Title: The timberline in the Azau Valley in the central Caucasus Mountains in the context of landforms and the geomorphological processes modelling the area

Author: Adam Łajczak, Barbara Czajka

Citation style: Łajczak Adam, Czajka Barbara. (2015). The timberline in the Azau Valley in the central Caucasus Mountains in the context of landforms and the geomorphological processes modelling the area. "Geographia Polonica" (2015, no. 2, s. 201-203), DOI: 10.7163/GPol.0024

Geographia Polonica
2015, Volume 88, Issue 2, pp. 201-203
http://dx.doi.org/10.7163/GPol.0024

INSTITUTE OF GEOGRAPHY AND SPATIAL ORGANIZATION
POLISH ACADEMY OF SCIENCES
www.igipz.pan.pl

www.geographiapolonica.pl

THE TIMBERLINE IN THE AZAU VALLEY IN THE CENTRAL CAUCASUS MOUNTAINS IN THE CONTEXT OF LANDFORMS AND THE GEOMORPHOLOGICAL PROCESSES MODELLING THE AREA

Adam Łajczak[1] • Barbara Czajka[2]

[1] Institute of Geography
Pedagogical University of Krakow
Podchorążych 2, 30-084 Krakow: Poland
e-mail: alajczak@o2.pl

[2] Faculty of Earth Sciences
University of Silesia in Katowice
Będzińska 60, 41-200 Sosnowiec: Poland
e-mail: barczajka@wp.pl

Abstract

This brief study depicts the Azau Valley in the central Caucasus Mountains in the context of landforms and the geomorphological processes modelling the area. The attached Plate shows the location of timberline and the distribution and extent of landforms of different origin.

Key words

the Azau Valley • central Caucasus Mountains • timberline • digital map

The Azau Valley, located between the northern slope of the main granite ridge of the Caucasus Mountains and the southern slope of the Elbrus volcanic cone, represents an example of a partly glaciated high-mountain valley modelled by slope and fluvial processes of great intensity (Łajczak 2009). The processes influencing valley morphology are only partly responsible for the complex timberline alignment in this area. This line delimits the altitudinal extent of birch-pine forest. The valley bottom section studied is located at an altitude of 2100 to 2800 m a.s.l., whereas the valley section located above it as well as the lateral valleys are occupied by glaciers. Above the southern slopes of the valley there is Mt. Cheget (3760 m a.s.l.) with cirque glaciers whereas Mt. Elbrus (5642 m a.s.l.), covered with an ice-cap, is located above the northern slopes of the valley. The southern slopes of the valley and the lower parts of the northern slopes are built of granite. The higher parts of the northern slopes of the valley are built up of layers of basaltic and dacitic lavas terminated by a vertical escarpment.

The contemporary morphology of the Azau Valley represents the result of a lava flow which originated about 1100 years BP, the transgression of valley glaciers during the Little Ice Age and glacial recession which started in the 1850s. Extensive erosion and the consequences of accumulation in the valleys cutting the southern slope of Mt. Elbrus and the Azau Valley were caused by jökulhlaup floods, which had occurred until the 18th century (Łajczak 2009). As glaciers retreated, loose material was deposited in the main and lateral valleys and on the slopes and was transported down to the bottom of the main valley. This process, especially in the sub-alpine and alpine zones, was favoured by the large slope inclination and high precipitation in the summer season. This causes rapid changes in slope and valley bottom morphology (see the Plate – *The timberline in the Azau Valley in the central Caucasus Mountains in the context of landforms and the geomorphological processes modelling the area*). The large intensity of the slope processes should not however be recognised as the only reason for a complex alignment of the timberline in this area.

The Plate presented in this paper was prepared on the basis of the geomorphological map of the Azau Valley, which was drawn at a scale 1:10,000 (Łajczak 2009). This shows the distribution and extent of landforms of different origin. Altitudinal data with an accuracy of 30x30 m was obtained by the application of the GDEM-2 Digital Elevation Model. The original analogue map was transformed into a digital one including geo-referenced features. It was necessary to obtain a high accuracy of transformation at the local scale and therefore the spline transformation was used with 150 control points. Visualisation of the area was prepared in the 2.5D technique, with all vector layers extruded and draped on the DEM. The timberline was defined based on interpretation of high-resolution satellite images obtained from the ESRI server – World Imagery. Dense forest (density >0.4) with trees at least 8 m high (for pines) was regarded as the criterion for a timberline. ESRI software: ArcMap and ArcScene 10.2.2., was applied to prepare all the analyses and visualisations.

At present the main geomorphological processes modelling the most dynamic landforms in the study valley include rockfall, the development of screes and gullies, solifluction, debris flows, snow and groundsnow avalanches, landslides, the building up of para-glacial, torrential and alluvial fans, the aggradation or deepening of watercourse channels. More dynamic, in terms of geomorphological processes, are the precipitous southern slopes of the valley. Despite this fact, the timberline is located higher on the southern slopes of the valley than on the opposite slopes with 'warmer' exposure. The differences in altitudinal location of birch-pine forest on the two sides of the valley may be explained by the influence of edaphic factors and probably by former shepherding. Because of the greater soil moisture on the 'cooler' north-facing slopes, forest may grow higher above sea level than on south-facing slopes, which have dry soils. This asymmetry in timberline altitude cannot be counteracted by the more intensive activity of processes modelling the steeper southern slopes of the valley. This may be confirmed by the presence of forest on the southern slopes of the Baksan Valley (which is a continuation of the Azau Valley) and the lack of forest on the opposite slopes as seen on the topographic map *Prielbrusie* (Kommisarov 2009). The lack of forests on the 'warmer' south-facing slopes in both the Azau and Baksan valleys may also be explained by their intentional removal due to the development of shepherding which preferred the more accessible slopes down in the valleys.

The location of the timberline shown on the attached geomorphological map is consistent with the location shown on the tourist map referred to above. In the Azau Valley the timberline reaches 2550 m a.s.l. on the north-facing slopes and 2200 m a.s.l. in the valley bottom. Lack of forest in many parts of the valley bottom probably results from snow avalanche activity and shepherding. These altitudes for the timberline are different from the values given by Bashenina et al. (1974a,b) for this part of the Caucasus Mountains. According to these authors, pine forest in this area reaches an altitude of 2100 m a.s.l. and birch-pine forest reaches a height 2300 m a.s.l., which is the same as the timberline altitude. The belt covered by rhododendrons, which occurs at a higher altitude, reaches 2700 m a.s.l.

Editors' note:
Unless otherwise stated, the sources of tables and figures are the authors' on the basis of their own research.

References

BASHENINA N.V., TUSHINSKY G.K., GOLUBIEV G.N., MIAGKOV S.M., 1974a. *Geomorphology of Elbrus Mt. area*. Studia Geographica, 44, Brno: Geografický Ustav. Ceskoslovenská Akademie Věd, pp. 9-86.

BASHENINA N.V., BRONNIKOVA V.K., RUBINA E.A., 1974b. *Routes in the Elbrus area in the region of Moscow State University Station*. Studia Geographica, 44, Brno: Geografický Ustav. Ceskoslovenská Akademie Věd, pp. 87-119.

ŁAJCZAK A., 2009. *Changes in relief of the Azau Valley in Central Caucasus Mts resulting from impact of volcanic activity and glaciers` oscillations during the last 1100 years*. Landform Analysis, 11, pp. 40-59.

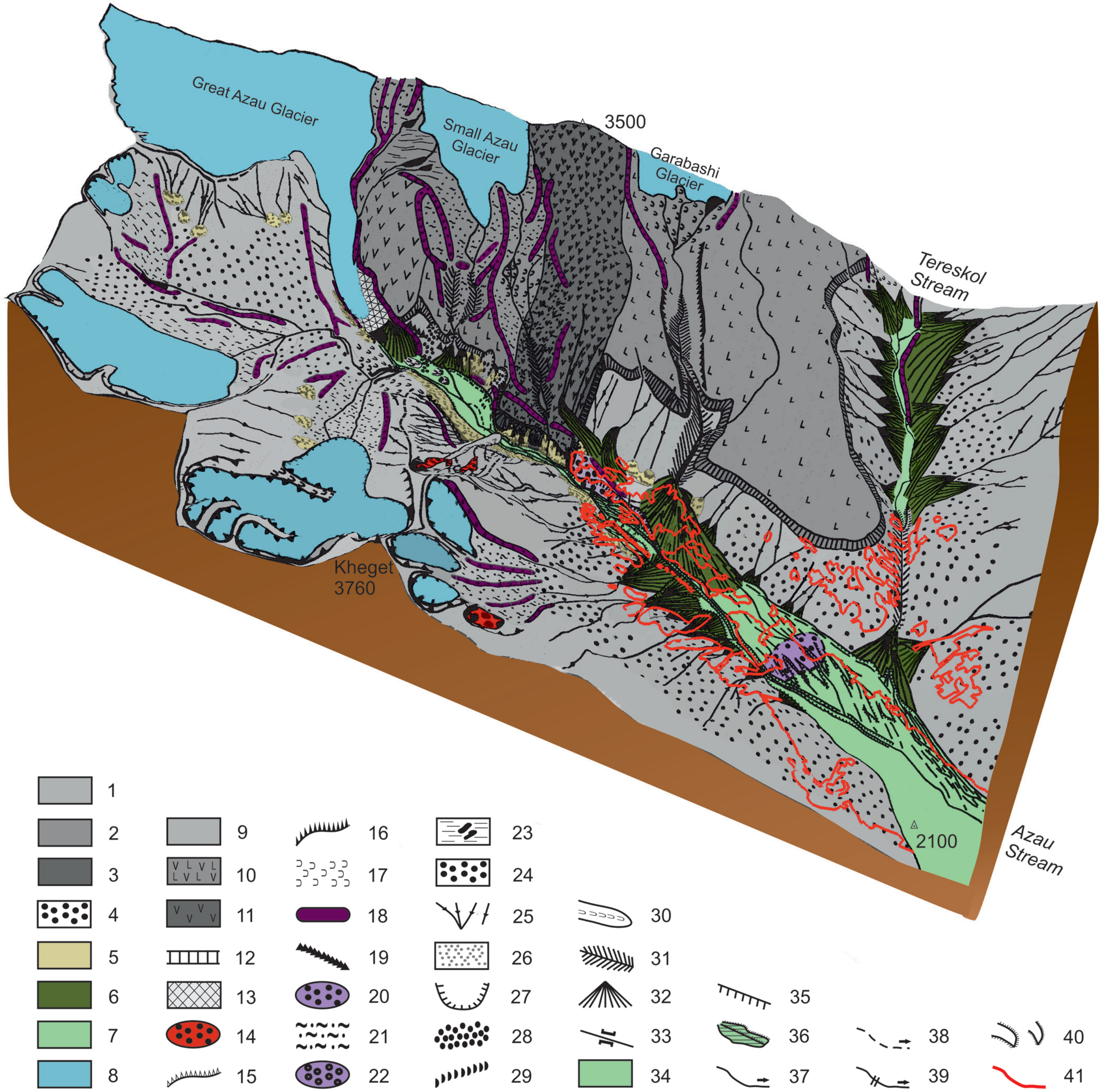
KOMISSAROV I., 2009. *Prielbrusie*. Topographic map at a scale of 1:100,000, Rostov upon Don.

Article first received • February 2015
Article accepted • April 2015

THE TIMBERLINE IN THE AZAU VALLEY IN THE CENTRAL CAUCASUS MOUNTAINS IN THE CONTEXT OF LANDFORMS AND THE GEOMORPHOLOGICAL PROCESSES MODELLING THE AREA

by Adam Łajczak • Barbara Czajka

based on the geomorphological map of the Azau Valley at a scale of 1:10,000 (Łajczak 2009)



BEDROCK

1 – granite rocks; 2 – older Holocene lavas; 3 – youngest lava flow (ca. 1100 BP); 4 – thick layer of debris and rock mantle in situ lying and covering large areas; 5 – thick layer of debris mantle building scree slopes and covering large areas; 6 – thick layer of debris and rock mantle building alluvial, torrential and paraglacial fans; 7 – thick layer of glaciofluvial material filling up the valley bottoms; 8 – current limit of glaciers

LANDFORMS

9 – slopes composed of granite rocks with thin debris cover; 10 – older Holocene lavas; 11 – youngest lava flow (ca. 1100 BP); 12 – volcanic rock walls; 13 – dead-ice; 14 – rock glaciers; 15 – vertical limit of slopes undercut by glaciers within U-shaped valley; 16 – vertical limit of glacially steepened slopes around cirques; 17 – roches moutonnées; 18 – fragments of frontal and lateral moraine ramparts formed since the 19th century; 19 – traces of lateral moraine ramparts visible as conical mounds of debris; 20 – fossilized frontal moraine rampart from about 1700; 21 – preserved ground moraine; 22 – ground moraine with dead-ice forms; 23 – lacustrine sediments with accompanying shallow lakes; 24 – field of boulders on slopes; 25 – rocky gullies; 26 – rockfall gravity sorted talus cones and slopes; 27 – niches of landslides; 28 – tongues of landslides; 29 – larger solifluction tongues; 30 – larger multi-annual snow patches; 31 – V-shaped incisions in glacial troughs; 32 – alluvial fans and paraglacial fans; 33 – gorges; 34 – valley floor built up of glaciofluvial material; 35 – erosion scarps in valley bottom; 36 – 2 m and 5 m terraces upstream of former frontal moraine rampart from ca. 1850; 37 – channels of permanent streams; 38 – channels of seasonal streams; 39 – waterfalls; 40 – incisions in the flat valley bottom in the vicinity of a fossilized frontal moraine rampart from ca 1700. The limits of the geomorphological processes shaping the area are mentioned in the text; a large number of debris flows and snow avalanche paths are not marked due to the small scale of the map; 41 – course of the timberline

To cite:
Łajczak A., Czajka B, 2015. *The timberline in the Azau Valley in the central Caucasus Mountains in the context of landforms and the geomorphological processes modelling the area*. Geographia Polonica, vol. 88, no. 2, pp. 201-203.